I. Introduction and Purpose

The Virginia Department of Environmental Quality Water Quality Monitoring Strategy

Please Note: *Many of the documents cited within the text are provided with hot-links to an accompanying file folder [*Folder "+00b_Linked_Documents (Feb13)"*]. If the relative location of the folder, the name of the folder, or the abbreviated name of any of the included files is altered, then the relative path description will change and the link(s) will no longer function. The abbreviated file name codes of all linked documents are also provided in brackets [...] adjacent to the corresponding links in order to facilitate identifying them when links become non-functional or when referring to a printed 'hardcopy' text. Hot-links to external Internet sites provide access to non-agency sources or to agency documents that may be revised and/or updated between this edition of the strategy and its next revision.*

A. Introduction

The Millennium 2000 Water Quality Monitoring (WQM) Strategy of the Virginia Department of Environmental Quality (VA-DEQ or DEQ) was first produced in draft form and submitted to the US Environmental Protection Agency (USEPA or EPA) Region 3 and to DEQ's Academic Advisory Committee (AAC) for review in December of 1999. Following formal oral presentations by the agency to the USEPA and to the AAC in 2000, the reviewers tentatively approved the original document and provided some suggestions for improving the overall WQM Strategy. DEQ subsequently carried out another formal presentation of the Strategy and submitted the document to an additional, independent Scientific Advisory Committee (SAC) for review in 2001. Final comments and a general approval from the SAC were received in late 2002. During the intervening period, from 2000 through 2003, DEQ adapted its strategy to incorporate a number of suggestions provided by the reviewing bodies, as well as to initiate the implementation of numerous new elements included in the strategy. In addition, a number of previously existing programs were adapted to changing needs, and the updated strategy document was revised for final, formal approval by the agency and the Commonwealth of Virginia.

DEQ believes that its present Water Quality Monitoring Strategy adequately describes and discusses the current needs of the agency and addresses all ten components set forth in the EPA/ASIWPCA[1] publication on "Elements of a State Water Monitoring and Assessment Program" [I-0a.pdf] (USEPA, 2003). Additional elements (**Chapter II - Virginia's Water Resources**) included in this WQM Strategy document are derived from a hardcopy draft guidance document on the development of water quality monitoring programs that was provided by EPA Region 3 in 1998. The comprehensive, statewide geographic and water resource type coverage provided by the current monitoring strategy are documented in the summary table "Monitoring Coverage of Water Resources" [I-0b.xls] linked to this document. The agency considers any formal strategy to be subject to continual revision and, consequently, the written form of the WQM Strategy to be an 'evolving document', which is subject to periodic review and adaptation as part of the agency's continuous planning process.

[1] U.S. Environmental Protection Agency and the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), more recently (2012) renamed the Association of Clean Water Administrators (ACWA)

B. Historical Overview

The original WQMA Strategy was developed by DEQ's Water Quality Monitoring Taskforce between July 1997 and December of 1999. During that period, representatives from DEQ's Central Office (Richmond) and from the six Regional Offices in existence at that time assembled bimonthly to review the structure of the existing program, evaluate the needs of water quality data users[2], and to define the direction, goals and desirable characteristics of the water quality monitoring program for the initial decade of the 21st century. The structures and functions of the various committees participating in this process are summarized below in Figure I-1 - Structure and Function of the Water Quality Monitoring Taskforce 1997-2000. A brief chronological summary of the Taskforce's establishment and activities is provided here as a table of Taskforce Milestones [I-0c.xls].

The agency's statewide Water Quality Monitoring Program consists of an integrated amalgam of various subprograms that vary in purpose and regional emphasis. A detailed description of the purpose, form, function and evolution of these subprograms is provided in **Chapter III - Design and Implementation** of this document. In brief, comprehensive geographic coverage of the state's surface waters is accomplished primarily by a statewide Watershed Monitoring Network, in conjunction with DEQ's Chesapeake Bay Monitoring Program, and by two Probabilistic Monitoring Networks that encompass all free-flowing fresh waters and all estuarine waters in the Commonwealth of Virginia. These are complimented by the agency's Trend Monitoring Network, Lakes Monitoring Program, Biological Monitoring Program, and Targeted Fish Tissue and Sediment Monitoring Program, as well as an integrated Citizen's Monitoring Program and other non-agency monitoring (for which DEQ has a full-time Non-Agency Monitoring Liaison), all of which provide nearly statewide coverage. With the aid of EPA grants the agency's Wetlands Monitoring Program was expanded into a comprehensive statewide survey. One product of these federal grants is a wetlands data viewer and assessment tool being developed through collaboration with the Virginia Institute of Marine Sciences (VIMS). This tool is currently in the final phase of development and should be released for public use in late 2013 or early 2014. Responsibilities for Virginia's Ground Water/Source Water Protection Program are divided among several state agencies, including the Department of Environmental Quality (DEQ), the Department of Conservation and Recreation (DCR), the Department of Health (VDH) and the Department of Mines, Minerals and Energy (DMME). The DEQ Ground Water Protection staff are currently in the process of developing a Ground Water Monitoring Strategy of their own.

C. Purpose

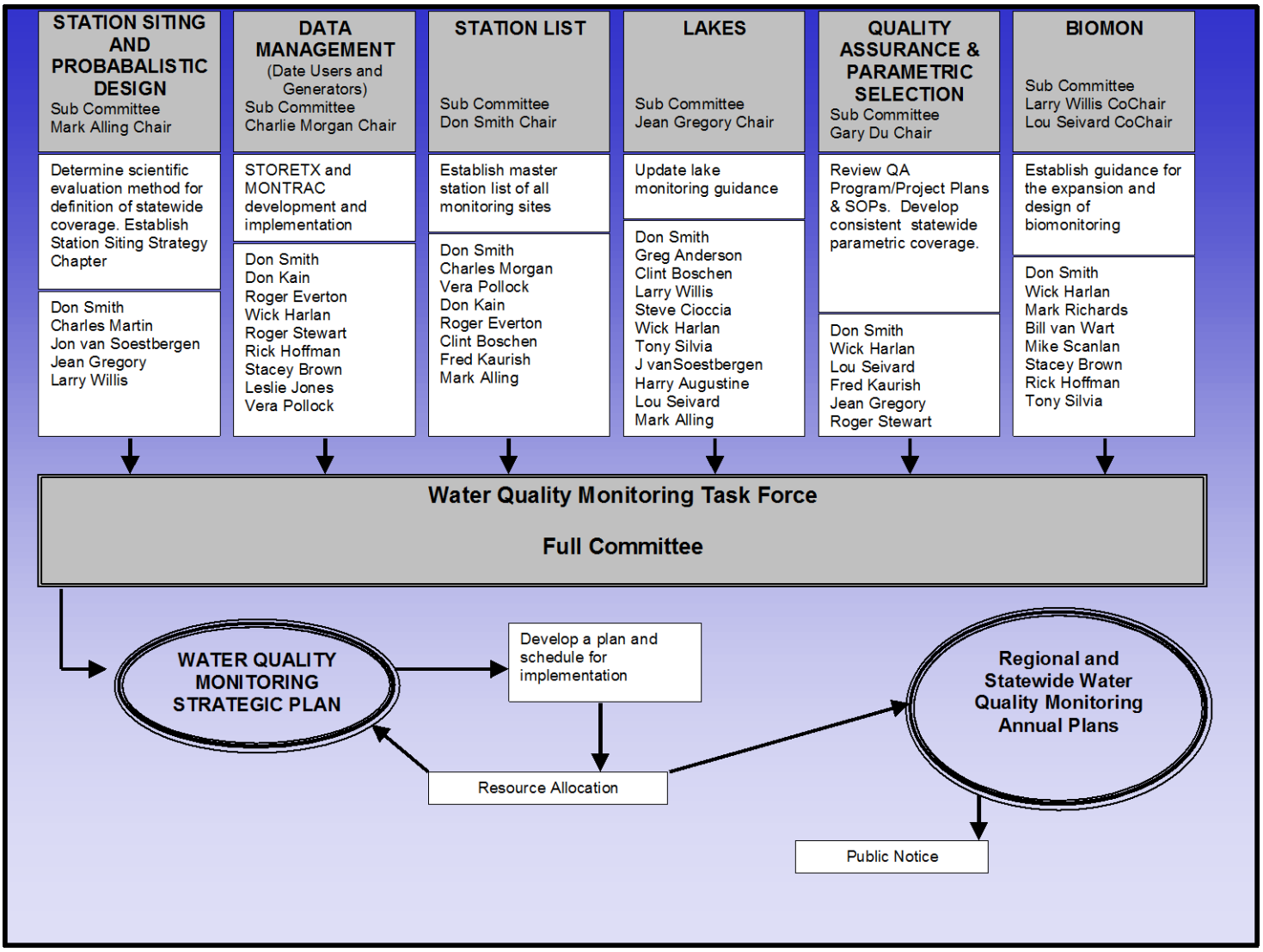
The primary purpose of the "Water Quality Monitoring and Assessment (WQMA) Program," developed and maintained by the Virginia Department of Environmental Quality, is to provide the answers to five basic questions concerning the water resources of the Commonwealth:

1. What is the overall quality of waters in the State?
2. To what extent is water quality changing over time?
3. What are the problem areas and the areas needing protection?
4. What level of protection is needed?
5. How effective are the established clean water programs?

[2] Representatives of the data users included the Virginia Department of Health, the Department of Conservation and Recreation, the Department of Forestry, and the Virginia Water Resources Research Center (Virginia Tech). In addition to the participation of these groups the Task Force conducted an statewide data generator and user survey to help define data sources and data needs.

The multiple facets of each of these questions, and the methodologies utilized for answering them, are described more fully in the remainder of this document. Their resolution will provide the information needed for attaining the ultimate goal of the WQMA Program.

Figure I-1 - Structure and Function of the Water Quality Monitoring Taskforce 1997-2000



D. Universal Goal

The ultimate goal of the Water Quality Monitoring and Assessment Program is to "***provide representative data that will permit the evaluation, restoration and protection of the quality of the Commonwealth's waters at a level consistent with such multiple uses as prescribed by Federal and State laws***."

In order to achieve this goal, and to satisfy scientific, legislative and esthetic requirements related to the quality of the Commonwealth's water resources, the VA-DEQ has established a series of specific objectives to identify and define the diverse functions of the Water Quality Monitoring and Assessment Program. Many of these specific objectives are directly related to five more general objectives set forth in the Clean Water Act (CWA):

1. ***Determination of water quality standards attainment*** *(Section 305(b)).*
2. ***Identification of impaired waters*** *(Section 303(d)).*
3. ***Identification of causes and sources of water quality problems*** *(Sections 305(b) and 303(d)).*
4. ***Support for the implementation of water management programs*** *(Sections 303, 314, 319, 402, etc.).*
5. ***Support for the evaluation of program effectiveness*** *(Sections 303, 402, 314, 319, etc.).*

E. Objectives

To attain the overall goal of the agency's WQM Program and the general objectives of the Clean Water Act, VA-DEQ has defined 19 specific objectives, divided into four general categories and six functional subdivisions.

1. Assessment and Remediation Objectives:

(A) Status Quo Characterizations and Assessments:

(1) Provide accurate, representative data for water quality characterization and assessment of all surface waters within the State.

(2) Establish consistent statewide siting, parameter selection and monitoring techniques, in order to ensure data reliability and the comparability of data.

(3) Assure that the frequency of sampling and the total number of observations collected are sufficient to provide adequate data for scientific, statistically based and defensible assessment procedures.

(4) Assure that, whenever possible and available resources permit, flow rates are determined simultaneously with the collection of other water quality data.

(5) Monitor, according to a plan and schedule, all substances discharged into state waters that are subject to water quality standards or are otherwise necessary to determine water quality conditions.

(6) Continually evaluate the overall success of the Commonwealth's water quality monitoring and management efforts.

(B) Impaired Waters / Remediation:

(7) Provide data to define the severity, geographic extension, and cause of impaired waters and to identify the source(s) of impairment.

(8) Provide adequate data for TMDL model development and validation.

(9) Provide adequate data, by means of follow-up monitoring, to evaluate the effectiveness of implementation of TMDLs and appropriate best management practices (BMPs).

(C) Variability, Trend Assessments and Forecasts:

(10) Provide adequate data and analytical procedures for short-, medium- and long-term statistical

evaluations of water quality variation and trends within identifiable, geographically or hydrologically defined water bodies.

2. Permit Objectives:

(11) Provide data for the calculation of permit limits for the issuance, re-issuance and/or modification of effluent discharge permits.

(12) When water quality problems are suspected, provide data to detect and document water quality impairments and/or to evaluate permit adequacy, whether permitted dischargers are in compliance with existing permit limits or not.

3. Efficiency and Quality Assurance Objectives:

(13) Improve the efficiency of the Monitoring Program by minimizing resource requirements and the duplication of efforts, while maximizing the use of integrated data collected within and among state and federal agencies, public utilities, private enterprises and citizens groups for statewide water quality assessments.

(14) Maximize, within the limits of resource availability, the collection and use of data on biological assemblages (e.g., benthic macro-invertebrates, fish, and/or aquatic vegetation), as well as fish tissue and sediment monitoring, for specific assessments of water quality.

(15) Identify, investigate, and characterize additional avenues of actual or potential water quality impairment, including ground water contribution and aerial deposition rates.

(16) Guarantee adequate Quality Assurance / Quality Control (QA/QC) procedures to provide precise, accurate and representative water quality data for all purposes.

4. Research Objectives:

(17) Provide data to validate special stream or site designations.

(18) Evaluate new methodologies for sampling, analyzing and assessing water quality.

(19) Provide data for other research objectives.

The universal goal and specific objectives of DEQ, as described above, are all directed toward providing the best possible answers to several specific types of questions concerning the evaluation of water quality and the management of aquatic resources.

F. Data Categories

Four categories of data uses that are pertinent to the design of DEQ's monitoring and assessment program are defined and discussed below. The first three are specific to water quality assessments and the fourth is intended to provide data for remedial solutions.

1. Studies of Spatial and Short-Term Temporal Variability

One of the primary goals of the strategy is comprehensive spatial and temporal coverage by monitoring activities in order to assess all state waters in the biennial 305(b) Water Quality Assessment Report. Waters identified as being impaired are specifically listed in the biennial 303(d) Report on Impaired Waters. Since 2004, DEQ has combined both the 305(b) Water Quality Assessment and the 303(d) Report on Impaired Waters into the Virginia Water Quality Assessment 305(b)/303(d) Integrated Report.

The Commonwealth's "Water Quality Monitoring, Information and Restoration Act" [I-0d.pdf] (WQMIRA - Article 4.01 of the Code of Virginia) also requires that monitoring and assessment procedures be representative and comparable statewide. In addition, there are a number of informative regional characterizations and comparisons that can and should be made among bodies of water, drainage basins and other geographic subdivisions, each of which is greatly facilitated by probabilistic survey monitoring.

2. Studies of Mid- and Long-Term Temporal Variability

a. Studies of short-term (daily, seasonal, or annual) variability, as discussed above, provide answers to questions such as*: "Is the specific water body of interest in compliance with state Water Quality Standards?" or "Does the specific water body of interest provide for designated uses at least 90% of the time?*" To answer such questions, it is necessary to evaluate the Water Quality Standard violation rate during a specified assessment interval. The results of water quality assessment during this interval or 'assessment window' are summarized in DEQ's biennial 305(b) Water Quality Assessment Report. For most water quality parameters, if the violation rate is greater than 10.5%, EPA requires DEQ to list the associated water body segment(s) in its biennial 303(d) Impaired Waters List. To answer these questions, it is not imperative to know the actual (quantitative) value for a water quality variable, but simply how frequently the value exceeds the standard.

b. Often, the evaluation of mid-term temporal variability (*e.g.*, changes in water quality from one assessment cycle to the next) is necessary to answer questions such as: "*Is the 'Waters of Concern' status of this stream segment still justified?*" or "*Has water quality at this monitoring station changed significantly since the last assessment cycle?*" Such questions may be answered by statistically comparing standards violation rates from one assessment period to the next (qualitative) or by examining changes in the numerical (quantitative) values of water quality parameters. In either case, monitoring methods must be consistent and data types comparable through time for reliable comparisons to be made.

c. Evaluations of long-term temporal trends provide the answers to questions such as; "*Do the values of a water quality variable reveal a tendency to increase or decrease over a specified (longer) time period?*" This is an important management question. Its answer provides an evaluation of our management techniques, allowing us to determine if they are successful and adequate. Numerical or quantitative values of a water quality variable are required for the evaluation of long-term trends. Long-term trends are typically measured using data sets from five to twenty or more years of monitoring activity. Currently, DEQ restricts long-term trend assessments to monitoring sites that have a minimum of 100 data points, distributed over a relatively continuous period. This implies a minimum time period of eight to ten years at a monthly sampling frequency.

d. In addition to site-specific trends, DEQ is also interested in geographic and temporal variability on a statewide scale. Because the agency has traditionally focused on site-specific monitoring stations, past analyses of data have also been predominantly site-specific in nature. Serious problems can occur when

site-specific results are extrapolated to regional or statewide evaluations. The statewide application of trend analyses is a necessity, but the agency has not collected data specifically for that purpose in the past. The probabilistic survey-sampling components of the monitoring strategy described in this document are capable of providing such information in an unbiased form.

3. Site-Specific Problem Characterization

In areas where known problems exist, DEQ's first responsibility is to determine "*What is the severity, spatial extent, cause, and source of the problem?*" Determining the spatial extent, severity, cause, and source often require intensive targeted special studies. Because of the enormous diversity of causes of impairment, the human and financial resources and time requirements for answering such questions are predominantly site- and/or problem-specific as well.

4. Remediation Studies

The monitoring program must also provide information to support the remediation of water quality problems. This often requires the collection of data for the development of water quality models. A significant increase in additional field data is needed for Total Maximum Daily Load (TMDL) model development. Once remediation studies have been completed and "Best Management Practices" (BMPs) have been implemented, additional monitoring is required to evaluate the effectiveness of the methods employed.

Having defined the goal and specific objectives of the monitoring strategy, it is fundamental to identify, characterize and understand the specific water resources that are being evaluated. The following section (**Chapter II – Virginia's Water Resources**) provides a general overview of the methods used to identify, to describe and to further characterize the surface-water resources of the Commonwealth.